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54 **Chemical vapour-deposition of aluminide coatings.**

57 The present invention provides a method and apparatus for coating nickel based alloy articles with NiAl coatings and cobalt based alloy articles with CoAl coatings by generating an aluminum chloride gas mixture with increased levels of AlCl in a vapor generator at a first temperature T₁ and flowing the resultant AlCl enriched aluminum chloride gases over the articles to be coated in a reactor at a second temperature T₂ wherein T₂ is at a substantially lower temperature than T₁, having a difference of at least 25°F and preferably about 150°F.

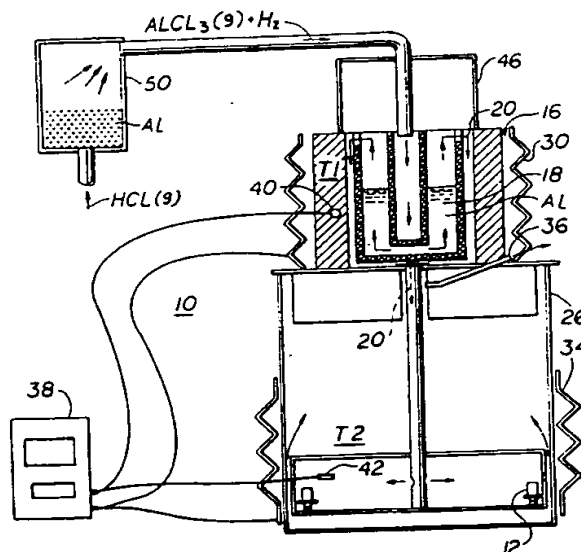


Fig. 1

chloride gas mixture 20. This is accomplished by maintaining a first temperature T1 in the generator 16 and a second temperature T2 in the reactor 26 such that temperature T1 remains substantially higher than said second temperature T2 during the reacting step of the coating process. It has been found that a temperature difference between T1 and T2 of as little as 25°F is sufficient and that a difference of about 150°F is preferred. Furthermore it is preferable to maintain the first temperature T1 in a range of about 1800°F to 2300°F and the second temperature T2 in range of about 1500°F to 2200°F.

Referring to FIGS. 1 and 2, the desired temperature levels and differences are maintained by a first heating means 30 in the form of an electrical furnace surrounding generator 16, and effective for maintaining the first temperature T1 in the generator and a second heating means 34 effective for maintaining the second temperature T2 in the reactor 26. A vent means 36 leading from reactor 26 vents the reacted gases to scrubbers (not shown).

A control means to continuously monitor and control the coating process and to operate the furnaces to maintain the desired temperature levels and differences is another feature of the preferred embodiment. The control means includes a first temperature sensing means, illustrated as a first thermocouple 40, to measure and output a first signal indicative of the first temperature T1 in the generator 16 and a second temperature sensing means, illustrated as a second thermocouple 42, to measure and output a second signal indicative of said second temperature T2. The first and second temperature signals are transmitted to a programmable computing means 38, via signal lines shown in FIG. 1, which is effective to receive the first and second temperature signals and control the first and second heating means 30 and 34 respectively to maintain a preselected first and second temperature schedule in accordance with the requirements of the present invention as well as other criteria relating to the process.

The preferred embodiment also provides for generating a low temperature aluminum trichloride $AlCl_3$ gas by passing HCl through a pre-generator 50 containing aluminum powder or aluminum pellets at a relatively low temperature T3, preferably about 500°F. The resultant aluminum trichloride gas is then flowed to the generator 16. The low temperature pre-generator is a cost effective and low temperature method for this step of the process. A preheater 46, preferably in the form of a heat exchanger, which may be powered by a less expensive source of heat than electricity, is also provided to help raise the temperature of the aluminum chloride gas mixture in an efficient and relatively inexpensive fashion. Electrical furnaces, though expensive to operate, are used for the first heating means 30 and the second heating means 34 because they are easy to control, and therefore are

used generally to provide the marginal amount of heat required to maintain the desired temperature levels while maintaining the temperature differentials between T1 and T2.

While the preferred embodiment of the present invention has been described fully in order to explain its principles, it is understood that various modifications or alterations may be made to the preferred embodiment without departing from the scope of the invention as set forth in the appended claims.

Claims

1. A process for coating an article with aluminum wherein the article is made of an alloy having a base metal from a group of metals including cobalt (Co) and nickel (Ni), said process comprising:
 - continuously generating an aluminum monochloride ($AlCl$) enriched aluminum chloride gas mixture in a generator operating at a first temperature T1,
 - continuously flowing the enriched aluminum monochloride gas mixture to a reactor,
 - reacting the $AlCl$ enriched aluminum chloride gas mixture on at least one article surface by flowing the resultant $AlCl$ enriched aluminum chloride gas mixture from the generator over the surfaces of the articles to be coated in the reactor continuously operating at a second temperature T2,
 - continuously venting the reacted gases out of the reactor, and
 - continuously operating the process with T1 at a substantially higher temperature than T2.
2. The process claimed in claim 1 wherein first temperature T1 is at least 25°F higher than second temperature T2.
3. The process claimed in Claim 1 or Claim 2 wherein generating the $AlCl$ enriched aluminum chloride gas mixture further comprises flowing aluminum trichloride gas through aluminum in the generator.
4. The process claimed in Claim 1 or Claim 2 wherein continuously generating the $AlCl$ enriched aluminum chloride gas mixture further comprises bubbling aluminum trichloride gas through molten aluminum in the generator.
5. The process claimed in Claim 1 or Claim 2 wherein continuously generating the $AlCl$ enriched aluminum chloride gas mixture further comprises flowing hydrogen chloride gas through aluminum-containing material in the generator.

6. An article made of an alloy based on a group of metals including cobalt (Co) and nickel (Ni), said article having a surface provided with at least one coating deposited according to the method of any preceding claim. 5
7. An apparatus for coating the surface of an article with aluminum wherein the article is made of an alloy based on a metal selected from the group consisting of cobalt (Co) and nickel (Ni), said apparatus comprising: 10
- a generator for generating an aluminum monochloride AlCl-enriched aluminum chloride gas mixture at a first temperature T1, 15
- a reactor in fluid communication with said generator and effective for receiving the AlCl-enriched aluminum chloride gas mixture from said generator and reacting the AlCl-enriched aluminum chloride gas mixture on the article surfaces by flowing the AlCl-enriched aluminum chloride gas mixture over the surfaces of the article at a second temperature T2 in said reactor, 20
- vent means for continuously venting the reacted gases out of said reactor, and 25
- control means to continuously maintain said first temperature T1 substantially higher than said second temperature T2 during the reacting step of the coating process. 30
8. The apparatus as claimed in claim 7 wherein said control means is effective for continuously maintaining said first temperature T1 of said generator at least about 25°F higher than said second temperature T2 of said reactor. 35
9. The apparatus as claimed in claim 7 wherein said generator for generating the AlCl enriched aluminum chloride gas mixture comprises a means for continuously flowing aluminum trichloride gas through a chamber in said generator containing aluminum. 40
10. The apparatus as claimed in claim 9 wherein said generator for generating the AlCl-enriched aluminum chloride gas mixture further comprises means for bubbling aluminum trichloride gas through molten aluminum in said chamber. 45
11. The apparatus as claimed in claim 7 wherein said generator for generating the AlCl-enriched aluminum chloride gas mixture comprises a means for continuously flowing hydrogen chloride gas through a chamber in the generator containing an aluminum source. 50 55
12. The apparatus as claimed in claim 7 further comprising a pre-generator for producing said aluminum trichloride gas.

said pre-generator in fluid supply communication with said generator,

said pre-generator effective to produce said aluminum trichloride gas at a lower operating third temperature T3 than said temperature T1 of the generator, and

said pre-generator producing said aluminum trichloride gas by flowing hydrogen chloride gas through aluminum in the pre-generator.

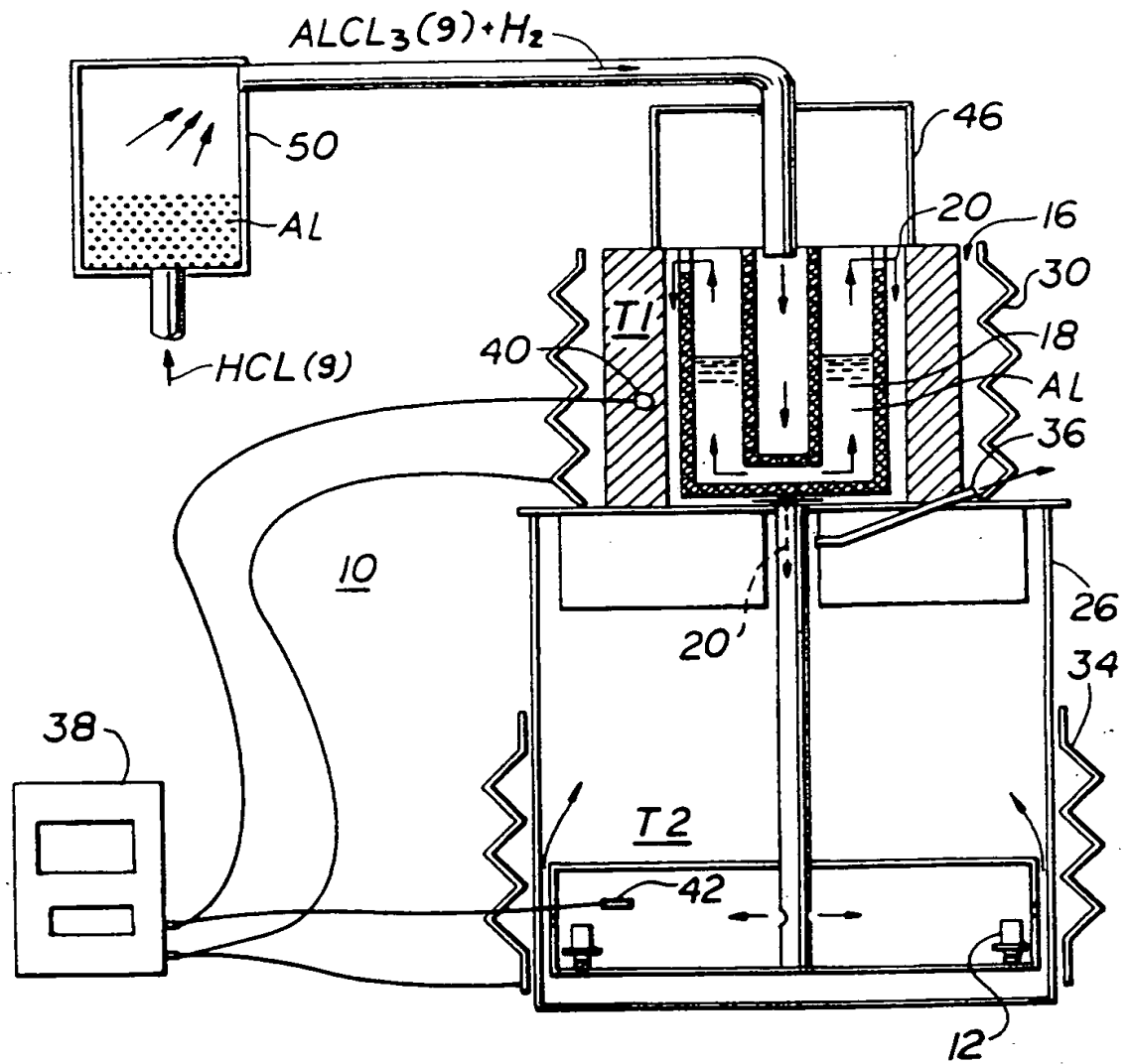


Fig. 1

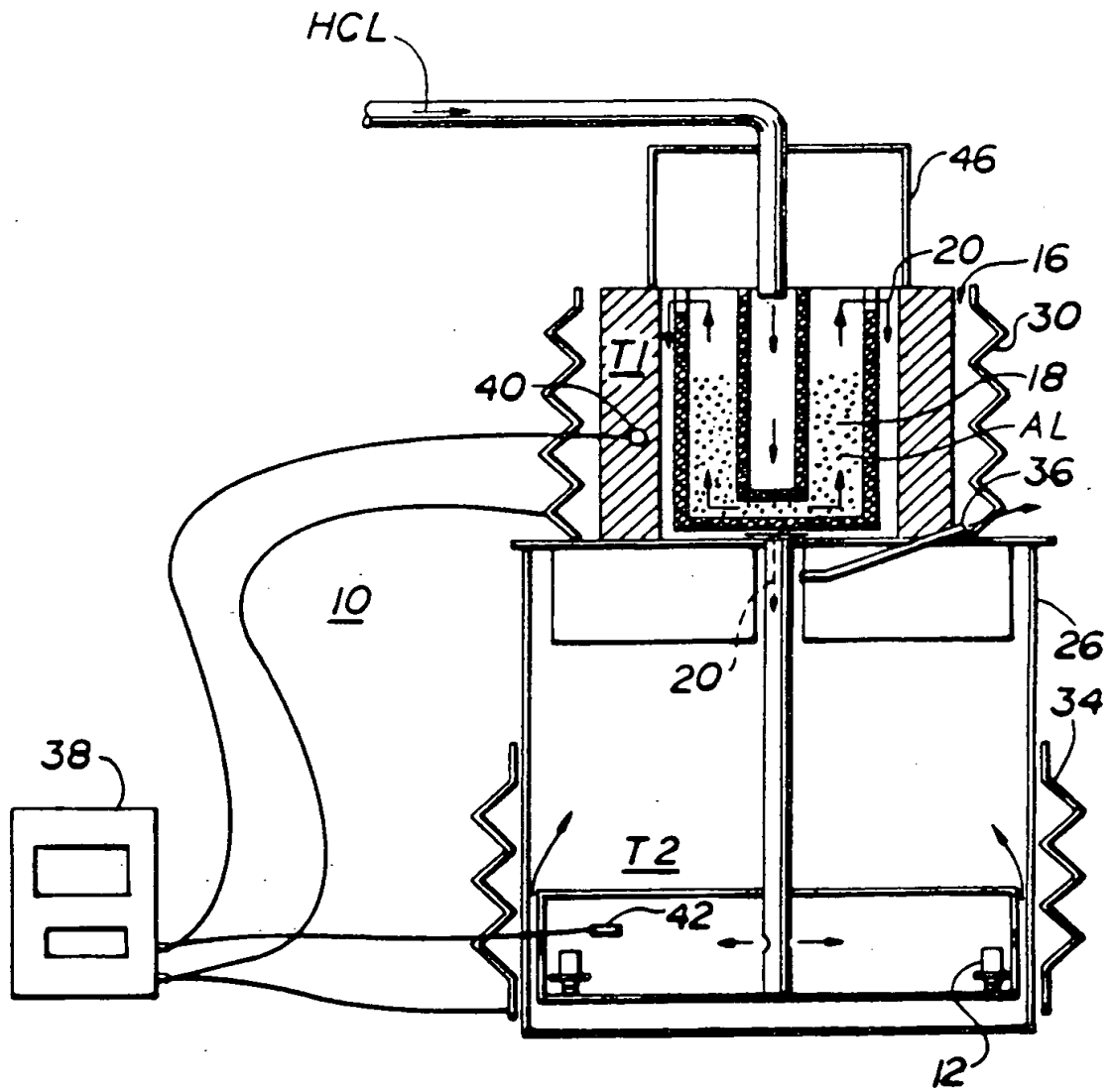


Fig. 2



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⑤④ Chemical vapour-deposition of aluminide coatings.

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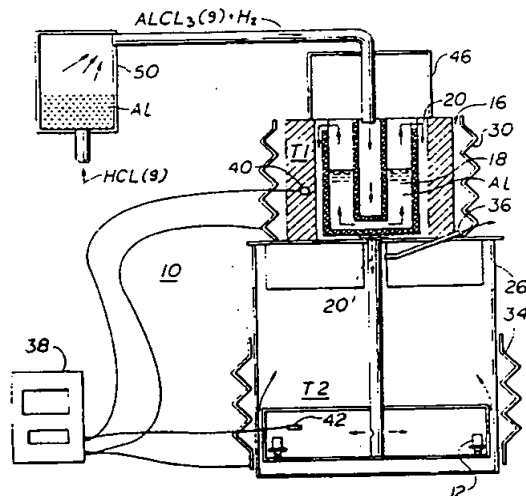


Fig. 1

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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 3799

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-28 05 370 (E. FITZER)	7-9	C23C16/08
Y	* page 5, line 7 - line 26 *	1-3, 6, 11, 12	C23C16/44
A	---	4, 5, 10	C23C16/12
Y	THIN SOLID FILMS vol. 146, no. 1, 2 January 1987, LAUSANNE CH. pages 55 - 64 WEN-PIN SUN 'KINETICS OF THE FORMATION OF NICKEL ALUMINIDE COATINGS ON PURE NICKEL BY CHEMICAL VAPOR DEPOSITION'	1-3, 6	
A	* page 56, line 14 - line 25; figure 1 *	4, 5, 7-12	
Y	US-A-2 643 959 (J. FISCHER) * column 2, line 14 - line 41 *	11, 12	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 112 (C-281)(1835) 16 May 1985 & JP-A-60 005 029 (KOGYO GIJUTSUIN) 11 January 1985 * abstract *	5, 10	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			C23C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 October 1993	Examiner EKHULT, H
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family, corresponding document	
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